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Geographic distribution extension of the Worm Salamander, *Oedipina complex* (Dunn, 1924), in the Magdalena Valley, Colombia

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Abstract

This study reports the salamander *Oedipina complex* (Dunn, 1924) in a tropical and relictual humid forest in the Magdalena Valley, Colombia. Previous records outline *O. complex* as a species associated with the pluvial forests of central and northern areas of the Chocó Biogeographic Region in Colombia, Ecuador, and Panama. Based on this new record, the geographic distribution of the species is expanded 257 km east.

Keywords

Boyacá, *Oedopinola*, relictual forests, Serrania de las Quinchas.

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Introduction

The genus of salamanders *Oedipina* Keferstein, 1868 contains only two species in South America within the subgenus *Oedopinola* (Köhler 2011; Garcia-Paris and Wake 2000; Savage 2002; McCranie et al. 2008), mainly occupying the Pacific lowlands in Colombia and Ecuador (Brame and Wake 1963; Acosta-Galvis 2019; Frenkel et al. 2019), along with a single unidentified specimen reported in the Magdalena Valley in Colombia (Ovalle-Pacheco et al. 2019). Considered a rare taxonomic group (McCraine et al. 2008), the number of individuals represented in Colombia is limited, not exceeding 20 specimens (Table 1).

One of the species reported for Colombia corresponds to the Colombian Worm Salamander *Oedipina parvipes* (Peters, 1879) which is widely distributed from central Panama to the northernmost foothills of the Cordillera Occidental and Cordillera Central of Colombia (Castro-Herrera et al. 2004; Frost 2019; Köhler 2011). It occurs within the tropical rain forests of the Panama canal zone and the central Cordillera of Panama, reaching the departments of Antioquia, Córdoba, Choco, Nariño, and Valle del Cauca in Colombia, between 43–150 m above

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Table 1. Localities with confirmed records of subgenus *Oedopinola* in Colombia. The records reported as *Oedipina complex* are represented at the distribution map with site (Fig. 2).

Species	Locality	Latitude	Longitude	Elev. a.s.l (m)	Site (Fig. 2)	Reference/collection
O. complex	Antioquia,Mutatá,Vereda Bedo Piñales, Finca La Bonga	07.1921	−076.3710	739	J	This study, Guido Medina-Rangel per. comm./GFM 1721
O. complex	Boyacá, Otanche Vereda Camilo, Santa Bárbara farmer, Cerro Morrocoy	05.0849	−074.1971	1043	K	This study/IAvH-AM-16458
O. complex	Cauca, Guapí, Gorgona Island, National Natural Park	02.9646	−078.1789	10	B	This study/IAvH-Am-7952-5
O. complex	Cauca, Guapí, Gorgona Island, near penal colony	02.9646	−078.1789	10	B	Brame and Wake 1963; Brame 1968; Vernet/USNM 152557
O. complex	Chocó, Unguía, Vereda Arquía, cerro Tacarcuna	08.0384	−077.2152	1150	H	Medina−Rangel et al. 2017
O. complex	Chocó, Acandí, Corregimiento de Sapzurro	08.6483	−077.3677	177	I	This study, Guido Medina-Rangel per. comm./GFM 508
O. complex	Chocó, Quibdó, Enviromental Station Instituto Investigacion Pacifico	05.7452	−076.5394	86	F	ICN-MHN-47956
O. parvipes	Antioquia, Mutatá	07.2494	−076.4258	296	–	Vernet/KU-MNH 140298
O. parvipes	Antioquia, Amalfi, Quebrada El Maní	06.9119	−075.0783		–	GBIF/MHUA-A 0456
O. parvipes	Antioquia, Valdivia, Quebrada Remolinos	07.2902	−075.3990	246	–	GBIF/MHUA-A 6473
O. parvipes	Antioquia, Cáceres, Cenía en el Río Cauca	07.5810	−075.3468	113	–	Brame and Wake 1963/ZMB 9518
O. parvipes	Cauca, El Tambo, La Cueva	02.7713	−076.9805	1132	–	MLS-61
O. parvipes	Córdoba, Tierra Alta	08.1131	−076.0551	201	–	ICN-MHN-54978
O. parvipes	Chocó, Condoto, Peña Lisa	05.0940	−076.6610	72	–	Brame and Wake 1963/BM 1914.5.21.90 (now NHMUK)
O. parvipes	Chocó, Bahía Solano, site La Virgen	06.2276	−077.4130	150	–	This study/IAvH-Am-6757
O. parvipes	Nariño, Barbacoas, Reserva Natural Biotopo Selva Húmeda, Corregimiento El Diviso, Vereda Berlín	01.4112	−078.2851	600	–	ICN-MHN-53644
O. parvipes	Valle del Cauca, Buenaventura, Río San Juan, zona de Guandal	04.1433	−077.4251	11	–	GBIF/UVC-14682
O. parvipes	Chocó, Río Quito, San Isidro	0.6263	−076.7488	43	–	GBIF/UTCH 0090

sea level (Brame and Wake 1963; Brame 1968; Savage 2002; Lynch and Suárez-Mayorga 2004; Raffaëlli 2007; Castro-Herrera and Vargas-Salinas 2008; Romero and Lynch 2012; Raffaëlli 2013; Mueses-Cisneros and Moreno-Quintero 2012; Fig. 1; Table 1).

Oedipina complex (Dunn, 1924) is the second species within the subgenus *Oedopinola* occurring in Colombia and has a current geographic distribution that extends from the eastern edge of the Pacific slope in Costa Rica near the Panama border through Panama and western Colombia, reaching northwestern Ecuador (Savage 2002; Köhler 2011; Acosta-Galvis 2019; Frenkel et al. 2019; Frost 2019; Fig. 1; Table 1). In Colombia, *O. complex* is recorded from the tropical rain forests of the Pacific lowlands with records at Gorgona Island in Cauca Department (Fig. 1B), and within the central pluvial region in Chocó Department, between 10–1250 m above sea level (Brame and Wake 1963; Brame 1968; Lynch and Suárez-Mayorga 2004; Raffaëlli 2007; 2013; Medina-Rangel et al. 2017). This species was described by Dunn (1924) from Las Cascadas, near Gamboa, Canal Zone in Panama (Fig. 1). Brame and Wake (1963) include two localities in the Gorgona Island in Colombia (Fig. 1), and in Paramba, Imbabura Province of Ecuador (Fig. 1). Subsequently, Brame (1968) included additional localities in Panama (Fig. 1).

Taxonomic studies of the genus *Oedipina* have been centered in Central America, where the diversity of species is high, with 38 species (Brame 1968; García-París and Wake 2000; Good and Wake 1997; Savage 2002; McCranie et al. 2008; McCranie and Townsend 2011; Köhler 2011; Frost 2019). However, the South American species *O. parvipes* and *O. complex* have received less attention due to the few specimens from isolated samples collected in Panama, Colombia, and Ecuador (Garcia-Paris and Wake 2000). Due to the lack of studies in South America, there is a current taxonomic chaos within both *O. parvipes* and *O. complex*, which are most probably composed of multiple cryptic species that need further studies in order to elucidate an appropriate taxonomic status (Garcia-Paris and Wake 2000; McCraine et al. 2008; Raffaëlli 2013).

During fieldwork in the expeditions of the project Boyacá BIO, in a survey of amphibians and reptiles associated with the Serrania de las Quinchas in Otanche Municipality, Boyacá Department (Fig. 1), a specimen of the genus *Oedipina* was collected and tentatively assigned to the species *O. complex*. This record has led us to extend the distribution of *O. complex* to the Middle Magdalena Valley region in Colombia.

Methods

The specimen was collected manually using the litter removal method in a terrestrial transect inside a tropical rain forest. It was euthanized with a solution of Benzocaine (Chen and Combs 1999), fixed in 10% formalin, and posteriorly stored in 70% ethanol. Voucher specimen is deposited at the amphibian collection of the Alexander von Humboldt Biological Resources Research Institute (IAvH-Am), Villa de Leyva, Boyacá Department, Colombia. Since morphological characters may be shared between Colombian species of *Oedipina*, we identified the specimen based on the previous revisions of Brame and Wake (1963), Brame (1968), Savage (2002), and Köhler (2011), together with the morphological review of additional specimens deposited at the amphibian collection (IAvH-Am). Morphometric measurements were made with digital calipers (nearest 0.01 mm) or a Nikon stereoscopic microscope SMZ-1B with

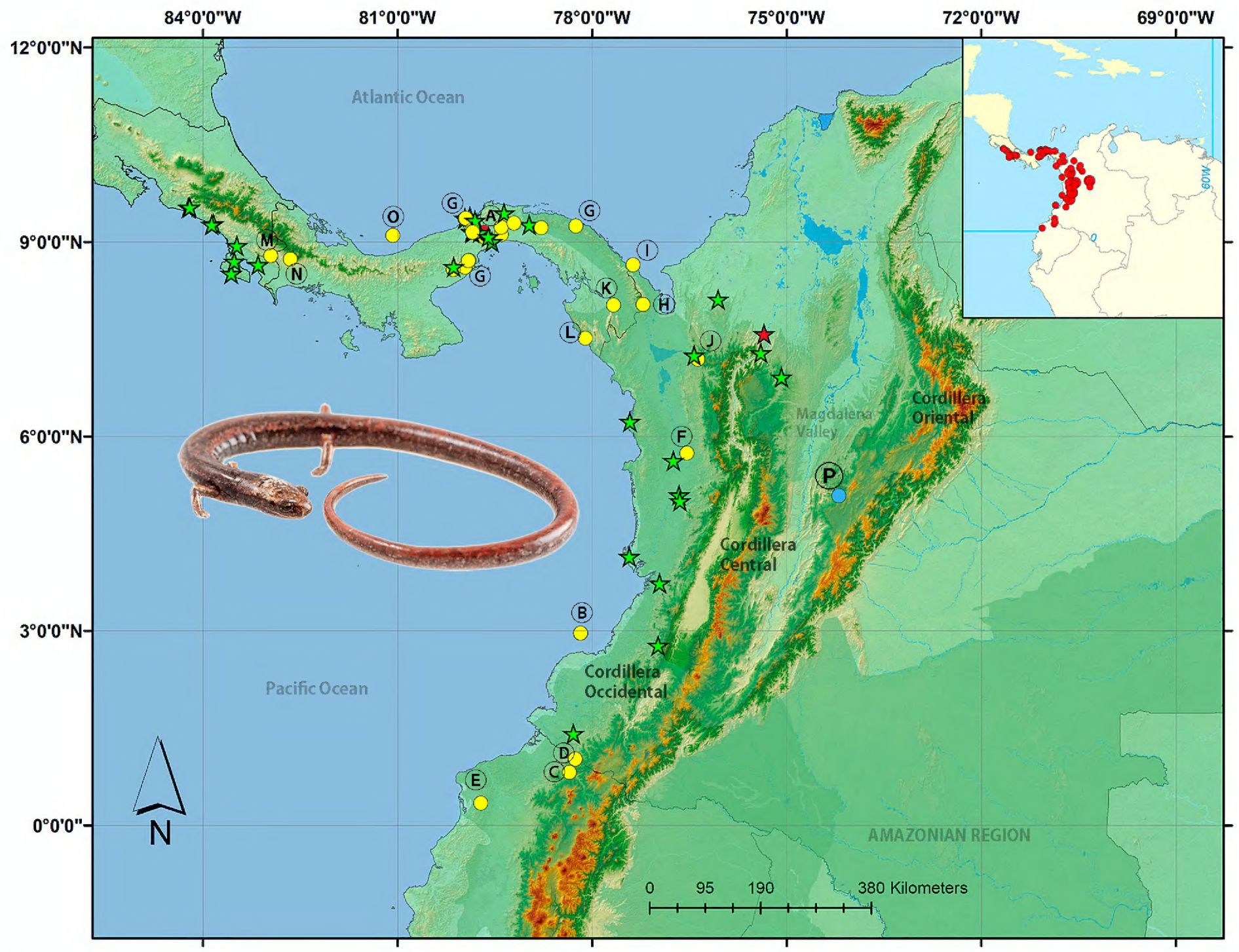

Figure 1. Geographical distribution of the subgenus *Oedopinola*: *Oedipina complex* **A.** Type locality (red dot) in Isthmian–Pacific moist forests ecoregion of Panama, published in the original description, MCZ 9408 (Dunn 1924; Brame 1968), Panama **B.** Chocó–Darien moist forests ecoregion, Municipality of Guapi, Cauca Department, Colombia (Brame and Wake 1963; Brame 1968). **C.** Western Ecuador moist forests, Province of Imbabura, Ecuador (Brame and Wake 1963; Brame 1968). **D.** Northwestern Andean montane forests, Province Carchi, Quinshull, Ecuador, QCAZA75501 (Frenkel et al. 2019). **E.** Northwestern Andean montane forests, Province Esmeraldas (Ortega-Andrade et al. 2010). **F.** Chocó-Darien moist forests ecoregion, Municipality of Quibdó, Chocó Department, Colombia (Lynch and Suárez-Mayorga 2004). **G.** Panamanians records from Isthmian–Pacific moist forests and Isthmian–Atlantic moist forests (Brame 1968). **H.** Chocó–Darien moist forests ecoregion, Municipality of Unguía, Chocó Department, Colombia (Medina–Rangel et al. 2017). **I.** Chocó–Darien moist forests ecoregion, Municipality of Acandí, Chocó Department, Colombia (GFM 508 collected by Guido F. Medina-Rangel). **J.** Chocó–Darien moist forests ecoregion, Municipality of Mutatá, Antioquia Department, Colombia (GFM 1721 collected by Guido F. Medina-Rangel). **K.** Chocó–Darien moist forests ecoregion, Darien, East base Cerro Pirre, Canal trail, KU116683. **L.** Chocó–Darien moist forests ecoregion, Darien, ridge between Rio Jaque and Rio Imamado. **M.** Puntarenas, from Finca Las Cruces, 6 km S, San Vito de Java, Costa Rica, LACM 109556-7 (VertNet 2020). **N.** Chiriquí, El Volcán, Panamá, ANSP 21663. **O.** Escudo Camp, west point of Isla Escudo de Veraguas, Costa Rica (VertNet 2020). **P.** Extension of its distribution (Blue dot), Magdalena–Uraba moist forest ecoregion, Otanche Municipality, Boyacá Department, Vereda Camilo, IAvH-AM-16458. Records for *Oedipina parvipes* (green stars), type locality (red star); Map with Arc Map 10.2.1.

High Intensity Illuminator NI-150 Nikon as follows: SVL (snout to anterior point of vent); SL (standard length, snout to posterior point of vent); M (maxillary teeth); V (vomerine teeth). An updated occurrence map of *Oedipina complex* in Colombia, based on museum surveys, the online vertebrate database (Vertnet, http://www.vertnet.org/index.html), and a comprehensive search of the scientific literature (Table 1) was generated using Arc-GIS version 10.2.1.

Results

During fieldwork in a relictual and tropical rain forest in July 2019, within a daytime survey, we observed a single specimen of a slender, elongate, and semifossorial salamander of the genus *Oedipina*. We found the specimen at 10:00 am while using a rake to remove the abundant leaf litter and roots within the humid substrate of the forest. At first, the individual remained motionless. However, when disturbed, it displayed an antipredator defense behavior by presenting irrational body flipping movements in a way that confused the investigators into thinking it was a piece of autotomized lizard tail.

New record. Colombia • 1 adult ♀, SVL = 41.9 mm, SL = 44.9 mm (Fig. 2); Boyacá Department, Otanche Municipality, Vereda Camilo, Santa Barbara farm, Cerro Morrocoy; 05.0849, −074.1971; 1043 m a.s.l; 30

Figure 2. *Oedipina complex* in vivo, IAvH-Am-16458 (SVL = 41.9 mm), Otanche Municipality (Boyacá). **A.** Lateral view. **B.** Dorsal view. (Photographs: Felipe Villegas).

July 2019; Daniela Garcia, Gladys Cárdenas, Azarys Paternina, Alejandro Corrales, and Luis Eberio Borda leg.; IAvH-AM-16458.

Identification. *Oedipina complex* is a small salamander (SVL 36.6–39.0 mm in adult males, $n = 5$ and adult females 38.2–44.1 mm, $n = 5$, sensu Brame 1968) that can be distinguished from *O. parvipes* by the following set of morphological characters (sensu Brame and Wake 1963; Brame 1968; Köhler 2011): maxillary teeth 13–45 (0–19 in *O. parvipes*), vomerine teeth 17–32 (9–19 in *O. parvipes*), venter dark black with a complete reticulum of melanophores (vs pale venter in *O. parvipes*), and maxillary teeth extending posteriorly past internal nares (never extending posteriorly in *O. parvipes*). The specimen reported here (IAvH-AM-16458) has 34 maxillary teeth (16 left and 18 right, Fig. 3) extending posteriorly past internal nares, 20 vomerine teeth (11 left and 9 right, Fig. 3), and a dark gray coloration in the venter. This combination of characters agrees with the diagnostic morphological characteristics of *O. complex*.

Discussion

In this study we expand the known distribution of *Oedipina complex* 257 km east of the nearest previously known occurrence record (Fig. 1). We tentatively assign the described specimen as belonging to *O. complex* based on the amount of morphological characters shared with the species diagnosis (Brame and Wake 1963; Brame 1968; Köhler 2011). Previous studies place the distribution patterns of the *O. complex* in the northwest

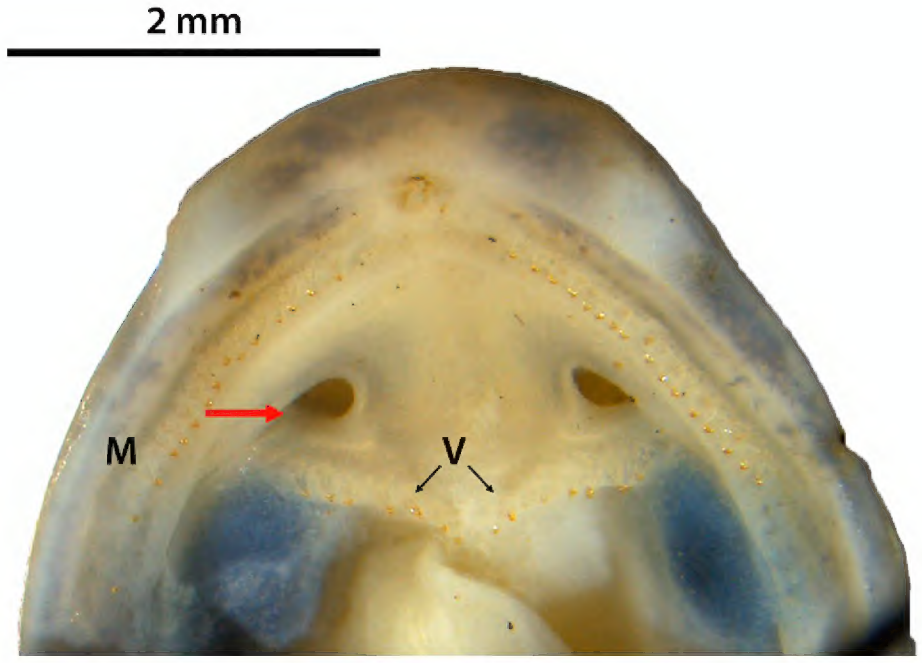

Figure 3. Details of head and teeth in ventral view of IAvH-Am-16458; V= vomerine teeth and M = maxillary teeth. Red Arrow indicates maxillary teeth extending posteriorly past internal nares. Scale bar = 2 mm. (Photographs: Andrés Acosta-Galvis).

of South America (Savage 2002; Castro-Herrera et al. 2004; Köhler 2011; Medina-Rangel et al. 2017; Acosta-Galvis 2019; Frenkel et al. 2019; Frost 2019) reaching the Pacific lowlands and the north of the Cordillera Central of Colombia. This study reevaluates the geographic range extension to inter–Andean middle Magdalena Valley in Colombia. *Oedipina complex* was originally recorded in regions of moist forests (Isthmian–Atlantic, Isthmian–Pacific, Chocó–Darien and Western Ecuador, *sensu* Olson et al. 2001) and in the northwestern Andean montane forests (Ecuador). Besides these regions, we confirm that *O. complex* occurs in the Magdalena Valley montane forests; and it is highly probable that the range of this species extends to other ecoregions such as Magdalena–Uraba moist forest (Fig. 1).

The presence of this specimen is important to demonstrate the strong connectivity within the central and northern Pacific region of Colombia and the humid forest of the Middle Valley of the Magdalena River. The connectivity between these regions shows a pattern of continual distribution of a large number of species associated to tropical humid forests (Lynch and Suárez 2004). The species associated with the subgenus *Oedopinola* are likely to display this distribution pattern; however, this should be evaluated.

Although the aim of this study is not to elucidate the taxonomic problem of *Oedipina* in Colombia, we think it is appropriate to mention the morphological incongruences between the two species reported for the country. Our direct evaluation of the morphological characters previously proposed for the diagnosis of *O. complex* and *O. parvipes* (Brame and Wake 1963; Brame 1968; Köhler 2011) in some Colombian specimens corroborate the impossibility of accurate taxonomic identification due to the uncertainty of these features. For example, the morphological evaluation of *O. parvipes* (IAvH-Am-6757 from Bahía Solano, Chocó) and *O. complex* (IAvH-Am-7953 from Gorgona Island) confirms this morphological ambiguity: the specimen IAvH-Am-6757 has maxillary teeth extending posteriorly past internal nares (= *O. parvipes* sensu Brame 1968; Köhler 2011), 43 maxillary teeth, with 22 left and 21 right (= *O. complex*), and vomerine teeth 10–14 (=*O. parvipes* sensu Brame 1968; Köhler 2011). Meanwhile, *O. complex* from Gorgona Island (IAvH-Am-7953) has maxillary teeth extending posteriorly past internal nares (= *O. parvipes* sensu Brame 1968; Köhler 2011), 27 maxillary teeth, with 13 left and 14 right (= *O. complex*), and 18 vomerine teeth with 10 left and 8 right (=*O. parvipes* sensu Brame 1968; Köhler 2011).

Likewise, Ovalle-Pacheco et al. (2019) reported a specimen of the genus *Oedipina* (ALOP–057) in the Magdalena river valley in Colombia and suggests, with significant taxonomic uncertainty, that this individual is a possible new species. Nevertheless, the taxonomic characters presented in Ovalle-Pacheco et al. (2019) study state that the specimen presents 14 maxillary teeth, which relates it to *O. parvipes* (sensu Brame 1968; Köhler 2011). However, the SVL reported (39.9 mm) fits the values proposed by Brame (1968) for *O. complex*. Another suggested features used in the specimen's identification, such as foot webbing, present a great variation in shape and size at intra–populational levels within the genus (Brame 1968; Raffaëlli 2013). Also, costal grooves will only allow a resolution at the level of a group of species (Brame 1968; Köhler 2011). These aspects show the need to review this specimen to assess the number of vomerine teeth along with the projection of the maxillary teeth against the internal nares.

To elucidate the problem of South American species within the subgenus *Oedopinola*, it is necessary to incorporate molecular tools that, in the first instance before designating new species, must involve the incorporation of topotypical populations of *O. parvipes* (from Cáceres, Antioquia, Colombia) and *O. complex* (from Canal Zone, Panama.). This should be done to measure to what extent the populations identified in Colombia are related to these species. Although Garcia-Paris and Wake (2000) previously evaluated the populations of *O. complex* near their typical locality from central Panama, they identify the need to include more populations. Our distribution extension reveals the geographic distribution of this rarely known species for Colombia.

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Authors' Contributions

ARA and DGC identified the specimen and wrote the manuscript; DGC, ACG, GCA, and APH collected the specimen and the ecological data related to the individual; DGC, ACG, GCA, and APH reviewed the manuscript text and complemented with additional observations of the field.

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